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THE INFLUENCE OF NUTRITION ON REPRODUCTIVE EFFICIENCY IN CATTLE*

I. The Effect of Calcium and Phosphorus Intake on the Fertility of Cows and Heifers

BY

S. L. HIGNETT AND P. G. HIGNETT,

FROM THE WELLCOME VETERINARY RESEARCH STATION, FRANT, SUSSEX

Although clinicians generally agree that nutrition influences reproductive efficiency in cattle, there is little detailed information published to support this view. In the present paper we endeavour to establish a relationship between reproductive ability and two of the many nutritional factors which are involved; the intakes of calcium and of phosphorus.

A number of workers including Eckles, Becker and Palmer (1926), Theiler, Green and du Toit (1928), Hart and Guilbert (1928), du Toit and Bisschop (1929), Wheeler (1945), Sheehy (1946) and O'Moore (1950) have drawn attention to the poor breeding record of cattle suffering from aphosphorosis, although it seemed to be accepted that fertility suffered only when other signs of aphosphorosis were apparent. The views expressed regarding the phosphorus requirements of the cow are somewhat conflicting, but, nevertheless, they are broadly in line with the recommendations contained in the Ministry of Agriculture's "Rations for Livestock," *i.e.*, $^4/_5$ oz. (23 grammes) P_2O_5 for maintenance and $\frac{2}{3}$ oz. (19 grammes) P_2O_5 for each gallon of milk. This publication also recommends $1\frac{1}{2}$ oz. (43 grammes) CaO for maintenance and $\frac{1}{2}$ oz. (14 grammes) CaO for each gallon of milk.

Apart from a paper by Webster (1932) in which he reports that there was a direct and statistically significant correlation between breeding efficiency and calcium intake, we have failed to find any evidence in the literature that the CaO intake influences bovine fertility. Webster, however, also found a closer correlation between the P_2O_5 intake or the CaO : P_2O_5 ratio and conception rate than between the CaO intake and conception rate.

Hignett (1950b) suggested that, when the P_2O_5 intake is only slightly in excess of minimum requirements, the CaO : P_2O_5 ratio bears some relationship to fertility.

During 1948 and 1949 preliminary observations were made from this Station on the feeding of dairy cattle on some 40 farms, chiefly in the winter months when the pasture contributed little or nothing to their nutrition. The findings suggested that a high CaO intake, a low or high P_2O_5 intake or a wide CaO : P_2O_5 ratio or a combination of these frequently were associated with poor fertility.

Too much importance could not be attached to these findings because on some farms the information as to feeding was not sufficiently detailed. Furthermore, only a few of the feeding-stuffs were analysed, estimates of calcium and phosphorus intakes being based on "text-book" CaO and P_2O_5 values. As more chemical analyses were done, it became obvious that these published values often differed materially from the values determined by analysis and that samples of any one food could differ widely in mineral content from farm to farm and with the season of harvesting.

Nevertheless, these observations were sufficiently interesting to warrant a more detailed investigation during the period October 1st, 1949, to March 31st, 1950: this period being chosen as that when pasture herbage, that very variable factor, played its smallest part in herd nutrition. A few of the animals in this survey had not been served by March 31st, but they were housed until the result of that service had been determined by rectal examination and had had no access to pasture since the previous year.

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INVESTIGATIONAL METHOD

Originally 50 farms were included in the survey, selected solely in the knowledge that full co-operation could be expected from the farmer, but an attempt was made to include farms of all types—those under bad as well as those under good management.

Table I (over-leaf) sets out the particulars of each of these herds and shows that, for various reasons, eleven herds could not be included in the analysis of the data obtained. In the remaining 39 herds 802 cows and heifers were available for observation.

Many of these farms were visited during September, 1949, to make preliminary observations. As from October 1st a careful record of oestrus, service and of feeding was kept and samples of feeding-stuffs taken for analysis. Further samples were taken from each new batch or mix of food. All sampling was carried out under the supervision of a veterinary surgeon or another competent person and a high proportion of the farms was visited regularly by one of us (P. G. H.) to collect samples and to check records. From time to time rations were weighed to confirm the records and owners and stockmen were questioned closely to ensure that trustworthy information was obtained. As each sample of food was received at the Wellcome Veterinary Research Station it was recorded and divided into two portions (in the case of succulent foods after drying in a hot-air oven). One portion was submitted to chemical analysis, either in our own laboratory or in that of one of the several workers who had kindly undertaken to help. The other portion was stored for possible future observations. The calcium and phosphorus contents of 639 samples of feeding-stuffs were determined.

Only cows served for the first time since calving, and heifers served for the first time, after October 1st, 1949, were included. Conception rate was that of these first services and was based on pregnancy diagnosis by rectal examination or on non-return to service within a minimum period of three months. Occasionally animals returned to service after three months and they were recorded as non-pregnant. Since information as to dates of oestrus was available until the end of June, 1950, at least, it is considered that, taking the time of year into account, we are

TABLE I

DETAILS OF HERDS INCLUDED IN SURVEY

Herd Number	Breed	Location	A.I. or N.S.	Number of cows served for first time during survey	Number of heifers served for first time during survey	Remarks
1	Ayrshire	East Sussex	N.S.	23	—	
2	"	"	"	38	—	3 cows not included—pregnancy not confirmed.
3	"	"	Both	17	—	
4	Shorthorn	"	N.S.	13	—	
5	Red Poll	"	Both	24	—	
6	Ayrshire	West Kent	A.I.	16	—	4 cows not included in final analysis —pregnancy not confirmed.
7	Guernsey	"	N.S.	6	—	
8	Friesian	"	Both	26	—	
9	Friesian and Guernsey	"	"	6	1	Herd not included in final analysis —insufficient information.
10	Ayrshire	East Sussex	N.S.	47	—	
11	"	"	A.I.	16	—	
12	Friesian and Guernsey	West Kent	"	9	—	Herd not included in final analysis —insufficient information.
13	Guernsey	East Sussex	N.S.	11	—	
14	Shorthorn	"	A.I.	14	—	
15	Friesian	West Kent	N.S.	26	—	
21	Ayrshire	East Sussex	A.I.	5	19	
22A	"	Hampshire	N.S.	20	—	Herd at grass until end of October.
22B	"	"	"	57	—	Ditto.
22C	"	"	"	15	—	Ditto.
22D	"	"	"	3	—	Ditto.
33	"	North Kent	A.I.	—	—	Herd not included in final analysis —insufficient information.
34	Jersey	East Sussex	Both	18	—	
35	"	"	"	6	4	Herd not included in final analysis —records not satisfactory.
46*	Ayrshire and Guernsey	East Kent	A.I.	1	1	
47*	Ayrshire	"	Both	6	9	
66	Shorthorn	Suffolk	A.I.	13	—	
75	Ayrshire	Worcs	"	19	7	
76	Crossbred	"	"	20	2	Herd not included—owner unable to supply sufficient records.
77	Crossbred Friesian	"	"	22	—	
78	Jersey	West Kent	N.S.	6	5	
79	Ayrshire	West Kent	Both	20	12	
80	Shorthorn	"	"	38	—	
84	Guernsey	East Kent	A.I.	8	—	
86	"	"	"	17	2	
95	Friesian	West Kent	N.S.	26	15	Herd not included—insufficient information.
96	S. Devon	Devon	A.I.	12	—	
97	"	"	"	14	10	Heifers not included in final analysis—pregnancies not confirmed.
98	"	"	"	6	1	Heifer not included in final analysis —insufficient information regarding rations.
100	Friesian	West Kent	N.S.	42	—	
107	"	"	"	29	—	
113A	Guernsey	Berks	"	7	—	Herd not included in final analysis —insufficient information.
113B	"	"	"	13	—	Ditto
113C	Non-pedigree Shorthorn	"	"	20	—	Ditto
114A*	Ayrshire	"	"	22	—	
114B*	"	"	A.I.	22	—	Herd not included in final analysis —*V. foetus* recovered from herd.
125A	Guernsey	East Kent	N.S.	21	8	
125B	Friesian	"	"	11	4	
141	"	Suffolk	A.I.	20	11	Herd not included in final analysis —insufficient information.
146	"	West Kent	N.S.	20	—	
147	Friesian, Guernsey & Shorthorn	"	Both	20	—	

* The information available concerning these herds only covers the months of January, February and March, 1950.
Abbreviations:—N.S. = Natural service. A.I. = Artificial insemination.

justified in assuming that extremely few pregnancies have been falsely claimed.

Milk yields for the period under review were taken from the milk recording sheets of the Milk Marketing Board.

The intakes of calcium and phosphorus on the day of service were calculated separately for each cow and heifer. However, one can learn little from the study of total intake figures since the requirement of the lactating is obviously different from that of the dry animal, the amount of milk being given also affecting the requirement. A dry cow with an intake of 50 grammes P_2O_5 per day might well be receiving a larger proportion of her requirement than a lactating animal taking in twice as much. This difficulty could be overcome only by adopting a standard of CaO and P_2O_5 requirements for maintenance and production and we adopted the recommendations given in "Rations for Livestock," and, using this adopted standard, each animal's requirement was calculated and this figure subtracted from the intake, the result being expressed as grammes of excess P_2O_5 or CaO. From this point where the word "intake" is used in this paper it means intake in excess of the Ministry standard.

In many cases there were frequent alterations in the ration—on some farms the production ration was different each week, although in these cases the change was slight. It is appreciated that the ration fed before and after service might have a profound effect upon fertility. Nevertheless, it was necessary for survey purposes to select the ration fed on a particular day as representing the intake of the animal and we chose the day of service. In any case it was found that one change in the ration usually caused only a slight change in CaO and P_2O_5 contents, since, in general, only one ingredient of the ration was changed at a time. The difference might, of course, be greater when kale finished and mangolds or silage were substituted.

χ^2 was calculated by the method described by Bradford Hill (1950) and P was obtained from the table of χ^2 reproduced by Hill from Fisher's "Statistical Methods for Research Workers."

RESULTS

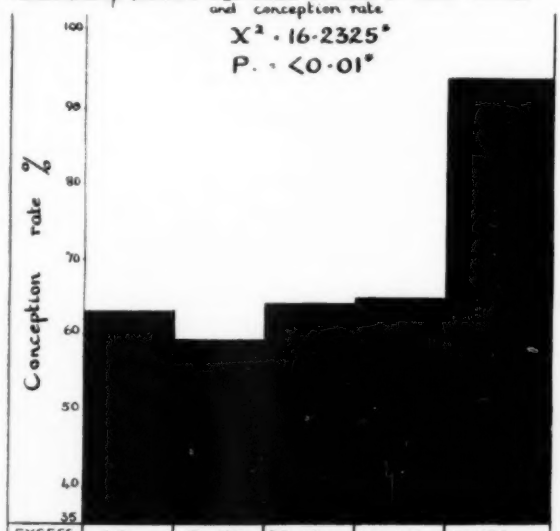
It will be seen from Diagram I that there appears to be a direct correlation between CaO intake and conception rate and, in fact, this table has a χ^2 of 16·232 and $P < 0{\cdot}01$, which indicates that the correlation is highly significant. It must be pointed out, however, that of the 33 animals in the group receiving more than 150 grammes excess CaO, 22 were from one farm and these animals also had the highest phosphorus intake of any in the survey. If this group of 33 animals (4 per cent. of the total) is deleted from the table it has a χ^2 of 2·284 and $P < 0{\cdot}7$, which indicates no degree of significance. Because of the high phosphorus intake of the 22 animals mentioned, one would probably be justified in withdrawing this group. It is interesting that of the 802 animals in the survey only 65 were receiving less CaO than the adopted standard.

Diagram II shows the effect of P_2O_5 intake on fertility; with a rise in phosphorus intake there was an associated and marked rise in conception rate up to the point when the animals were receiving 20 grammes or more of P_2O_5 in excess of the adopted standard requirement.

The data in Diagram II are also statistically significant; χ^2 is 18·576 and $P < 0{\cdot}01$. It will be seen that 97 animals were receiving less P_2O_5 than the Ministry of Agriculture recommendation.

DIAGRAM I

Relationship between CaO intake at time of first service and conception rate



EXCESS CaO g	<0 gms.	0–50 gms.	50–100 gms.	100–150 gms.	>150 gms.
No. of Animals	65	322	243	139	33*
% holding to first service	63	59	64	65	91*

Total number of cows and heifers 802

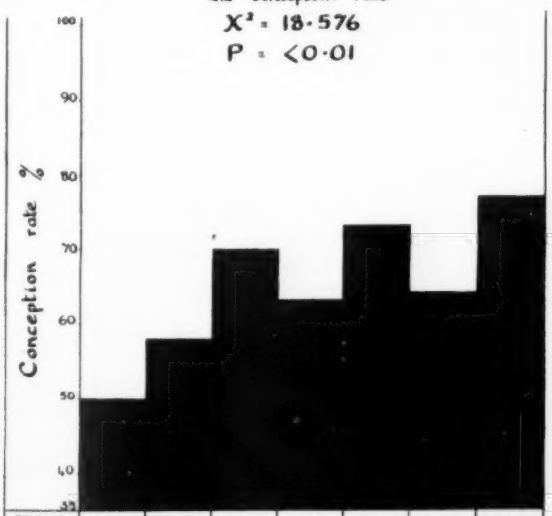
Average conception rate (based on first service) 63·3%

* Amount above (0·3 gms. for maintenance + 1·6 gms. per gallon of milk

* But see text, page 605.

DIAGRAM II

Relationship between P_2O_5 intake at time of first service and conception rate



EXCESS P_2O_5 g	<0 gms.	0–20 gms.	20–40 gms.	40–60 gms.	60–80 gms.	80–100 gms.	>100 gms.
No. of Animals	97	233	198	136	67	49	22
% holding to first service	50	58	70	64	73	65	77

Total number of cows and heifers 802

Average conception rate (based on first service) 63·3%

* Amount above (2·3 gms. for maintenance + 1·9 gms. per gallon of milk

In Table II a comparison has been made between the fertility of groups of cattle receiving phosphorus in accordance with different maintenance and production levels. In compiling the table, cows and heifers which were receiving within 10 grammes of the combined maintenance and production levels were grouped. It will be appreciated that using this method many animals appear in more than one group.

TABLE II

EFFECT OF VARIOUS P_2O_5 STANDARDS FOR MAINTENANCE AND PRODUCTION ON CONCEPTION RATE BASED ON FIRST SERVICE OF COWS AND HEIFERS

P_2O_5 for maintenance	P_2O_5 per gallon					
	19 grammes		25 grammes		31 grammes	
	Number of animals	C/R	Number of animals	C/R	Number of animals	C/R
23 grammes ...	123	50%	257	63%	143	65%
30 „ ...	195	56%	219	63%	130	62%
40 „ ...	273	63%	182	60%	142	61%
50 „ ...	231	67%	158	63%	147	69%
60 „ ...	159	66%	124	72%	102	76%

Abbreviation: C/R = Conception rate.

It is clear that fertility tends to rise as the phosphorus intake is increased and the difference of 26 per cent. between the group receiving 23 grammes for maintenance and 19 grammes for each gallon and the group receiving 60 grammes for maintenance and 31 grammes for each gallon is particularly striking. Twenty-three grammes P_2O_5 for maintenance and 19 grammes for each gallon of milk is the recommendation made by the Ministry of Agriculture, but some of the animals in this group in Table II were receiving 10 grammes less than this standard.

In Table III is shown the effect of CaO intake (expressed as excess over the adopted standard) on the fertility of groups with different P_2O_5 intakes. Whilst the numbers of cattle in each sub-group are too small to allow of any definite conclusion being drawn, it will be seen that in the lower phosphorus intake groups there is a tendency for fertility to drop as the amount of calcium consumed rises. On the other hand, in those groups with a high phosphorus intake the sub-groups with a low calcium intake show low fertility. With a rise in amount of calcium consumed there is a rise to a satisfactory conception rate which is not affected by a further rise in calcium consumption. These observations support the statement by Hignett (1949, 1950a, 1950b) that a calcium-phosphorus imbalance due to both excess of calcium over phosphorus and *vice versa* is often associated with a breeding problem.

This is further illustrated by Diagrams III and IV in which the conception rate has been correlated with the CaO : P_2O_5 ratio of cattle on different levels of phosphorus intake. It will be seen that in the case of cows and heifers receiving less than 20 grammes excess P_2O_5, conception rate decreases as the ratio widens, but in cattle receiving 20 grammes or more excess P_2O_5 the converse happens.

In Diagram III $\chi^2 = 10{\cdot}623$ and $P < 0{\cdot}05$; it is therefore significant.

Diagram IV in which χ^2 is 9·596 and $P < 0{\cdot}05$ is also significant.

DISCUSSION

Although this article is based on the observation of only 802 animals and the analysis of 639 samples of feeding-stuffs and there may have been errors in sampling and recording and a large number of bulls of varying fertility were used, we feel justified in drawing tentative conclusions. Our findings suggest that there is a relationship between P_2O_5 intake and fertility. There is a similar relationship between CaO and fertility, when the P_2O_5 intake is low or high.

TABLE III

EFFECT OF CaO INTAKE ON THE FERTILITY OF GROUPS OF CATTLE WITH VARYING P_2O_5 INTAKES

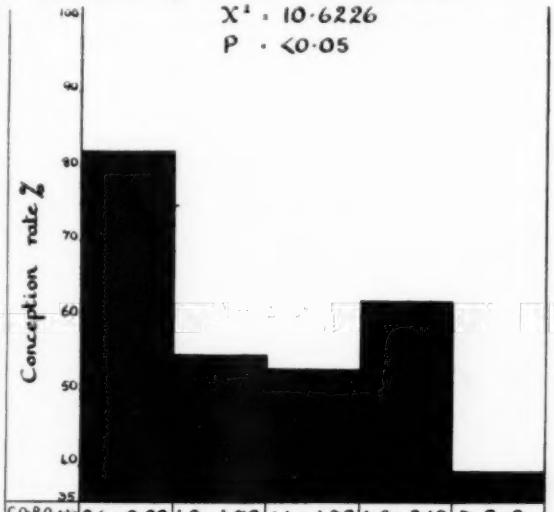
P_2O_5 per gallon ...		19 grammes						25 grammes						31 grammes					
P_2O_5 for maintenance	Excess CaO* (grammes)		<0	0–50	50–100	100–150	150–200	>200	<0	0–50	50–100	100–150	150–200	>200	<0	0–50	50–100	100–150	150–200	>200
23 grammes	(a)	23	61	34	5	—	—	10	162	56	27	2	—	5	60	54	24	—	—	
	(b)	14	28	19	1	—	—	7	100	38	16	1	—	3	42	30	18	—	—	
	(c)	61%	46%	56%		—	—	70%	62%	68%	59%		—		70%	55%	75%	—	—	
30 grammes	(a)	22	112	48	13	—	—	5	143	53	17	1	—	2	54	49	20	1	4	
	(b)	15	59	30	5	—	—	3	86	35	13	1	—	1	29	31	15	1	4	
	(c)	68%	53%	62%	38%	—	—		60%	66%	76%		—		54%	63%	75%			
40 grammes	(a)	25	175	50	21	2	—	3	80	72	27	—	—	—	49	59	19	5	10	
	(b)	22	101	35	14	1	—	1	45	43	20	—	—	—	21	39	14	3	10	
	(c)	88%	58%	70%	67%		—		56%	60%	74%	—	—	—	43%	66%	74%		100%	
50 grammes	(a)	8	143	57	21	2	—	—	55	71	32	—	—	—	32	52	43	3	17	
	(b)	6	94	38	17	1	—	—	31	45	23	—	—	—	18	35	29	2	17	
	(c)		66%	67%	81%		—	—	56%	63%	72%	—	—	—	56%	67%	67%		100%	
60 grammes	(a)	—	71	75	13	—	—	—	24	50	24	4	22	—	14	31	44	1	12	
	(b)	—	48	47	10	—	—	—	17	32	16	3	22	—	11	22	32	1	12	
	(c)	—	68%	63%	77%	—	—	—	71%	64%	67%		100%	—	78%	71%	73%		100%	

Abbreviations: (a) Number of animals served for first time.
(b) „ „ „ holding to first service.
(c) Conception rate based on first service.

* Amount above { 43 grammes for maintenance. / 14 „ per gallon of milk.

DIAGRAM III

Relationship between $C_aO : P_2O_5$ ratio and conception rate for animals receiving less than 20 gms. excess* P_2O_5



$C_aO : P_2O_5$ ratio (P_2O_5 expressed as 1)	0·6–0·99	1·0–1·39	1·4–1·79	1·8–2·19	>2·2
No. of Animals	49	186	87	47	41
% holding to first service	82	55	53	62	39

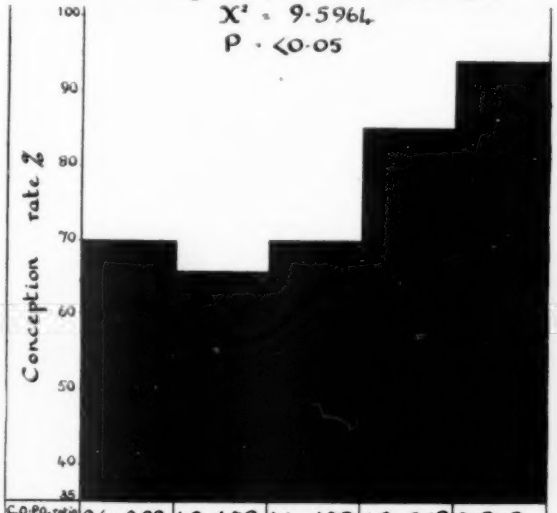
Total number of cows and heifers 330

Average conception rate (based on first service) 55·76%

* Above { 23 gms for maintenance / 19 gms per gallon of milk

DIAGRAM IV

Relationship between $C_aO : P_2O_5$ ratio and conception rate for animals receiving 20 gms. or more excess* P_2O_5



$C_aO : P_2O_5$ ratio (P_2O_5 expressed as 1)	0·6–0·99	1·0–1·39	1·4–1·79	1·8–2·19	>2·2
No. of Animals	91	256	89	20	16
% holding to first service	70	66	70	85	94

Total number of cows and heifers 472

Average conception rate (based on first service) 68·64%

* Above { 23 gms for maintenance / 19 gms per gallon of milk

According to our observations, for high fertility in the winter the P_2O_5 intake for dairy cattle in this country should be considerably higher than that previously accepted as adequate. Hignett (1949, 1950a, 1950b) has suggested that the calcium intake of many dairy cows in this country is considerably higher than it was 12 years ago and it may well be that for this reason the phosphorus requirement is now much higher than that previously accepted as adequate. Meigs and his co-workers (1926) showed that an excess of calcium in the ration interferes with the utilisation of phosphorus. Furthermore, it has been reported that iron interferes with the utilisation of phosphorus. A number of herds included in the survey were kept on farms in the South-East of England where the water supply is chalybeate. It is possible that this water has been responsible, at least in part, for the higher P_2O_5 requirements as indicated in Diagram II.

It is possible, also, that other factors exist which interfere with the utilisation of phosphorus by cattle in this country, factors which may not have influenced phosphorus utilisation in cattle observed in some other lands, *e.g.*, a high magnesium intake, lack of vitamin D, etc.

Few herds in this survey had a poor breeding record. In fact, with a conception rate of 63·3 per cent. based on first services, this group of 802 animals can be considered as having a fairly satisfactory fertility. In the course of our investigations into herd breeding problems in various parts of the country we have encountered a number of herds in which the affected animals have had calcium and/or phosphorus intakes outside the range encountered in this survey. It seems reasonable to assume that the calcium and/or phosphorus intake played some part in these herd problems, since steps to reduce calcium and/or increase phosphorus intakes have led to spectacular improvement in the breeding efficiency in these herds.

It must be appreciated that in some, but not all, instances an increase in P_2O_5 intake has been associated with an increase in carbohydrate and protein intake and that these increases might account for the higher fertility. On the other hand, spectacular improvement in the conception rate in some of these herds has been obtained by adding sodium acid phosphate to the existing ration. An *ad hoc* heifer feeding experiment not yet completed at this Station indicates that, when starch and protein intakes remain constant, fertility increases with increased consumption of phosphorus, within limits.

From Table II we conclude that housed cows and heifers receiving at least 50 grammes of phosphorus (P_2O_5) for maintenance and 19 grammes for each gallon of milk have an appreciably higher conception rate than animals receiving less. The heifer feeding experiment already mentioned appears to indicate that, for satisfactory fertility, our housed heifers must receive a minimum of approximately 50 grammes P_2O_5 per day. It may be that the cow does not require this high P_2O_5 intake for maintenance and to maintain high fertility. Always bearing in mind that the division between maintenance and production allowances is purely arbitrary, it should be pointed out that in the group in Table II receiving 50 grammes P_2O_5 for maintenance and 19 grammes P_2O_5 for production there were 203 cows and 28 heifers. The former had a conception rate of 70 per cent., the latter a conception rate of 57 per cent. On the other hand, in the group receiving 23 grammes P_2O_5 for maintenance and 19 grammes for each gallon of milk there were 110 cows with a conception rate of 53 per cent. and 13 heifers, four of which held to the first service.

It would appear that cows as well as heifers require considerably more than 23 grammes P_2O_5 for maintenance if high fertility is to be achieved.

Our experience suggests that the CaO intake should be in excess of the P_2O_5 intake.

If for high fertility a phosphorus intake considerably higher than that previously accepted is required it could be one explanation of the drop in conception rate sometimes noted when cattle are on leys. Many leys supply sufficient protein and carbohydrate for maintenance and four gallons of milk, but do not supply sufficient phosphorus for maintenance, production of four gallons of milk and high fertility. Furthermore, such pasture herbage often contains a marked excess of CaO over P_2O_5. This must not be considered a criticism of ley farming but of our management of and expectation from leys. Much of the infertility we encounter, associated with a calcium-phosphorus imbalance, is in grazing cattle, particularly on temporary pasture, where the soil is rich in lime and poor in both phosphate and potash. On the other hand, since the vitamin D status of the grazing animal is likely to be higher than that of the housed animal, its phosphorus requirement might be lower and it might be capable of tolerating a wider CaO : P_2O_5 ratio.

In reporting these observations we stress that we regard them as little more than pointers. We would wish to see this type of work repeated on a much larger scale. Such an investigation would have to be undertaken under the auspices of some central body prepared to correlate data received from various participating centres. In this article we have dealt with only one section of our observations on the effect of nutrition on bovine fertility and would warn against exaggeration of the importance of the influence of calcium and phosphorus intakes.

Summary

1. Details of an investigation of the effect of calcium and phosphorus intakes on fertility in cows and heifers are given.

2. In a group of 802 cows and heifers we were able to demonstrate that when P_2O_5 intake was low a rise in CaO intake impaired breeding efficiency, but when P_2O_5 intake was high a low CaO intake was often associated with low fertility and a high CaO intake with high fertility.

3. For high fertility in dairy cattle it appeared that the P_2O_5 intake should be considerably higher than the generally accepted 23 grammes for maintenance and 19 grammes for each gallon of milk.

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APPENDIX

The following three tables illustrate the method used in this survey. They relate to Herd No. 146, a Friesian herd using natural service.

Table i

Ration for Maintenance During Period of Survey

Sample number	Foodstuff	Content in fresh matter CaO %	Content in fresh matter P_2O_5 %	Amount fed per day lb.	Content of daily ration CaO grammes	Content of daily ration P_2O_5 grammes
From October 1st to December 31st, 1949						
138	Cabbage	0·98	0·435	3	13·4	5·9
146	Oat silage	0·87	0·363	6	23·7	9·9
164	Ryegrass hay	1·25	0·5	14	79·4	31·7
313	Oat straw	0·518	0·12	5	11·7	2·7
			Total content:		128·2	50·2
From January 1st to January 12th, 1950						
138	Cabbage	0·98	0·435	3	13·3	5·9
146	Oat silage	0·87	0·363	6	23·7	9·9
164	Ryegrass hay	1·25	0·5	14	79·4	31·7
292	Mangolds	0·093	0·046	9	3·8	1·87
313	Oat straw	0·518	0·12	5	11·7	2·7
			Total content:		131·9	52·07
From January 13th to March 31st, 1950						
146	Oat silage	0·87	0·363	10	39·5	16·5
164	Ryegrass hay	1·25	0·5	12	68·0	27·2
292	Mangolds	0·093	0·046	20	8·4	4·17
			Total content:		115·9	47·87
322*	Dried grass	1·72	0·48	4	31·2	8·7

* Fed to some cows as indicated in Table iii, in addition to maintenance and production ration.

TABLE ii
RATION FOR PRODUCTION DURING PERIOD OF SURVEY

Sample number	Period fed	Content in fresh matter	
		CaO %	P_2O_5 %
159	1.10.49–20.11.49	1·68	1·71
157	21.11.49–27.11.49	2·19	2·62
158	28.11.49– 4.12.49	1·2	1·64
247	5.12.49– 9.12.49	1·7	1·66
248	10.12.49–24.12.49	0·9	1·18
317	25.12.49– 9.1.50	1·28	1·2
316	10.1.50 –12.1.50	1·35	1·7
582	13.1.50 –20.2.50	0·91	1·37
576	21.2.50 –27.2.50	1·26	1·63
575	28.2.50 – 4.3.50	1·38	1·93
580	5.3.50 – 8.3.50	1·28	1·75
574	9.3.50 –22.3.50	1·58	1·96
578	23.3.50 –29.3.50	1·59	1·82
581	30.3.50 –31.3.50	1·38	1·74

These concentrates consisted of straight foods mixed on the farm, the ingredients varying with availability but essentially oats, dried grass, dried sugar beet pulp, maize gluten, ground nut meal, bean meal, soya bean meal, flaked maize, fish meal, steamed bone flour and common salt.

TABLE iii
CaO AND P_2O_5 INTAKE AT TIME OF SERVICE

Cow number	Date of service	Daily milk yield in gallons	Production ration : lb. per day	Intake*		Result of service
				CaO grammes	P_2O_5 grammes.	
9	12.10.49	3·5	12	219·6	143·3	P.
8	29.10.49	2	8	189·1	112·2	P.
1	2.11.49	3	12	219·6	143·3	P.
12	26.11.49	1·5	5	177·9	109·6	P.
17	26.11.49	3	10	227·5	169·0	N.P.
6	1.12.49	3·5	12	193·5	139·4	P.
18	21.12.49	3	12	177·2	114·3	P.
7	30.12.49	1·5	6	163·0	82·8	N.P.
15	11.1.50	4·5	14	217·6	160·0	P.
5	13.1.50	2	7	144·8	91·4	P.
10	21.1.50	4	14	173·7	134·9	P.
19	28.1.50	4	14	173·7	134·9	P.
2†	6.2.50	6·5	23	242·0	199·5	P.
3	6.2.50	3·5	13	169·5	128·6	N.P.
20	9.2.50	2	6	140·7	85·1	P.
16	11.2.50	3·5	13	169·5	128·6	P.
11	19.2.50	3·5	11	161·3	116·2	P.
14†	20.2.50	4·5	18	221·4	168·4	P.
13	27.2.50	2	7	155·9	99·6	N.P.
4†	31.3.50	6	21	278·5	222·3	P.

* The sum of the contents of the maintenance and production rations (plus dried grass where appropriate) fed on the day of service.
† Received dried grass.
Abbreviations: P. = Pregnant. N.P. = Non-pregnant.

RESEARCH DEVELOPMENT CORPORATION

Sir Hartley Shawcross, President of the Board of Trade, has made three new appointments to the membership of the National Research Development Corporation, and has reappointed those members whose initial periods of service recently expired. The corporation now comprises:—

Sir Percy Mills (Chairman), Lord Halsbury (Managing Director), Professor P. M. S. Blackett, F.R.S., Professor E. C. Dodds, F.R.S., Sir John McL. Duncanson, Sir Edward H. Hodgson, Mr. W. E. P. Johnson, Mr. J. F. Lockwood (new appointment), Sir Rowland Smith (new appointment), Sir Edward de Stein, and Sir Henry Tizard, F.R.S. (new appointment).

THE EFFECT OF STREPTOMYCIN ON THE FERTILITY OF BULL SEMEN

BY

D. L. STEWART, D. R. MELROSE AND W. R. WILSON

MINISTRY OF AGRICULTURE AND FISHERIES, READING
CATTLE BREEDING CENTRE, READING

Early in the development of insemination techniques it was realised that all samples of semen collected by means of an artificial vagina might be contaminated to a greater or lesser extent with various types of micro-organisms. Consequently the control of bacterial growth in semen stored for use in artificial insemination has been considered a subject requiring investigation.

Salisbury and Knodt (1947) investigated the effect of adding sulphanilamide to the normal citrate diluent and although an increase in fertilising capacity was reported, it was not attributed to the bactericidal effect of the drug.

Almquist, Thorp and Knodt (1948) demonstrated that the addition of penicillin to the yolk-citrate diluent had no adverse effect on the viability of spermatozoa, in amounts that retarded bacterial growth. Later, Almquist (1949) showed that the addition of penicillin to the diluent increased the fertility of semen from certain bulls with a history of poor fertility in artificial insemination. Studies by Almquist, Glantz and Thorp (1948) indicated that the addition of streptomycin to semen diluents in amounts up to 1,000 microgrammes per ml. had no injurious effect on the viability of spermatozoa.

In view of these reports it was decided to study the effect on the fertility of semen of adding an antibiotic to the normal yolk-citrate diluent used for routine inseminations. Streptomycin was selected for this purpose since it is effective against a wider range of organisms than penicillin and has been shown to have no adverse effect on the viability of spermatozoa. Investigations were made during two periods, January to April, 1950, and July, 1950, to January, 1951.

MATERIAL AND METHODS

The control diluent used in this investigation consisted of equal parts of egg yolk and 3·6 per cent. sodium citrate ($Na_3C_6H_5O_7 . 2H_2O$) solution in sterile, glass distilled water; the trial diluent being identical, with the addition of 1,000 microgrammes (*i.e.*, 1,000 units) streptomycin calcium chloride complex per ml.

There was no particular reason for choosing streptomycin calcium chloride complex for this investigation and probably other salts would have given similar results. It is interesting to note that Easterbrooks, Heller, Plastridge and Jungherr (1950) reported that laboratory tests revealed that streptomycin C.C.C. was precipitated when used with a phosphate buffer; therefore, the citrate buffer should be used. They found no significant difference when comparing the effect of streptomycin C.C.C. and dihydrostreptomycin sulphate on semen at a 500-microgramme level in a controlled experiment involving 1,166 cows.

Semen samples were diluted 1 : 20, 1 : 50 and 1 : 100 with the control and streptomycin diluents, stored at a temperature of 4° C. and examined microscopically at regular intervals for motility.

In the first trial, equal volumes of diluted semen were prepared from each ejaculate using the control and strepto-

mycin diluents. The dilution was 1 : 50 or 1 : 20 according to the breeding history of the bull, and the quality of the semen as shown by microscopic examination at the time of collection. To ensure that approximately equal numbers of unselected cows were inseminated by the control and the streptomycin diluents respectively, the inseminators were divided into two equal groups, using the prepared semen dilutions alternately each day. This ensured that they were both used by all the inseminators and that they were distributed evenly throughout the area served by the Centre. The conception rate was estimated as the percentage of first inseminations not reported to have returned to service within a period of 16 weeks from the date of insemination. Semen was collected three times weekly and used for two days except on Sundays when three-day-old semen was used.

The trial during the second period differed from the first in that all semen samples were diluted to the extent of 1 : 50 and semen collections were made every third day; consequently all samples were used for insemination on three successive days. This was done to allow comparisons to be made between the diluents on the three days on which the semen was used after collection.

Because of the lack of adequate facilities, no bacteriological examinations could be made during these investigations.

RESULTS

The storage tests confirmed previous work and showed that streptomycin had no adverse effect on the viability of spermatozoa stored at 4° C. up to a period of 15 days.

The results of the fertility trials are shown in Tables I to V, the significance of the increase in conception rate having been determined by the Chi-square test.

TABLE I

(First Period)

Day of use	Control diluent		Streptomycin diluent		Difference	Value of P
	Number of first inseminations	% Non-returns after 16 weeks	Number of first inseminations	% Non-returns after 16 weeks		
1st	909	62·4	900	68·4	+ 6·0	0·01–0·001
2nd	928	59·1	832	67·9	+ 8·8	<0·001
3rd	167	52·7	160	61·3	+ 8·6	N.S.
Totals	2,004	60·0	1,892	67·6	+ 7·6	<0·001

N.S. = Not significant.

TABLE II

(Second Period)

Day of use	Control diluent		Streptomycin diluent		Difference	Value of P
	Number of first inseminations	% Non-returns after 16 weeks	Number of first inseminations	% Non-returns after 16 weeks		
1st	1,088	56·0	1,147	70·2	+14·2	<0·001
2nd	1,102	54·6	1,172	66·8	+12·2	<0·001
3rd	1,200	53·8	1,283	59·9	+ 6·1	0·01–0·001
Totals	3,390	54·7	3,602	65·5	+10·8	<0·001

TABLE III

(First Period)

Bull	Age in years	Control diluent		Streptomycin diluent		Difference	Value of P
		Number of first inseminations	% Non-returns after 16 weeks	Number of first inseminations	% Non-returns after 16 weeks		
S1	7	270	68·8	261	70·8	+ 2·0	N.S.
S2	10	110	64·5	119	73·9	+ 9·4	N.S.
S3	3	229	66·3	226	66·8	+ 0·5	N.S.
S10	1½	28	—	21	—	—	—*
S11	2	6	—	14	—	—	—*
S12	8	52	40·3	53	75·0	+34·7	<0·001
G1	11½	320	32·5	310	62·6	+30·1	<0·001
G2	8	59	33·8	63	58·5	+24·7	0·02–0·01
G3	4½	129	60·4	118	60·1	— 0·3	N.S.
G7	1½	172	70·3	163	68·0	— 2·3	N.S.
F1	7½	144	68·0	115	76·5	+ 8·5	N.S.
F2	6	28	—	30	—	—	—*
F4	3	219	67·5	202	73·2	+ 5·7	N.S.
F5	5	238	70·1	198	66·1	— 4·0	N.S.
Totals		2,004	60·0	1,892	67·6	+ 7·6	<0·001

N.S. = Not significant. * = Data inadequate.

TABLE IV

(Second Period)

Bull	Age in years	Control diluent		Streptomycin diluent		Difference	Value of P
		Number of first inseminations	% Non-returns after 16 weeks	Number of first inseminations	% Non-returns after 16 weeks		
S1	7	526	66·0	533	65·7	— 0·3	N.S.
S2	10	488	41·0	580	64·5	+23·5	<0·001
S3	3	16	—	16	—	—	—*
S12	8	216	45·4	210	66·2	+20·8	<0·001
G3	4½	16	—	22	—	—	—*
G7	1½	228	64·9	280	73·6	+ 8·7	0·05–0·02
G8	4½	446	52·0	487	68·2	+16·2	<0·001
G9	1	227	60·4	252	58·7	— 1·7	N.S.
G10	1	207	63·3	226	66·8	+ 3·5	N.S.
F1	7½	330	41·5	355	63·7	+22·2	<0·001
F4	3	428	51·2	406	65·8	+14·6	<0·001
F5	5	262	70·6	235	62·1	— 8·5	0·05–0·02†
Totals		3,390	54·7	3,602	65·5	+10·8	<0·001

N.S. = Not significant. * = Data inadequate.
†= This bull showed with the control diluent an increase (significant at 1 per cent. level) over the streptomycin diluent.

TABLE V
GROUP A*

Day	Control diluent		Streptomycin diluent		Difference
	Number of first inseminations	% Non-returns after 16 weeks	Number of first inseminations	% Non-returns after 16 weeks	
1st	469	68·9	510	70·6	+ 1·7
2nd	465	65·8	491	65·2	— 0·6
3rd	513	62·2	525	61·1	— 1·1
Totals	1,447	65·5	1,526	65·6	+ 0·1

* = Group A consists of bulls S1, G7, G9, G10 and F5 from Table IV.

TABLE V (*cont.*)

GROUP B†

Day	Control diluent		Streptomycin diluent		Difference
	Number of first inseminations	% Non-returns after 16 weeks	Number of first inseminations	% Non-returns after 16 weeks	
1st	605	45·3	623	70·2	+24·9
2nd	626	46·3	675	68·2	+21·9
3rd	677	47·6	740	59·7	+12·1
Totals	1,908	46·4	2,038	65·7	+19·3

† = Group B consists of bulls S2, S12, G8, F1 and F4 from Table IV.

In the first period (Table I) there was a highly significant increase in the conception rate on all inseminations in the streptomycin treated group. This was confirmed during the second period (Table II).

The increase in fertility in the streptomycin group was highly significant on the first and second days in the first period and on all three days in the second period. In view of the inadequacy of the data and since all third-day inseminations in the first period were carried out on Sundays, these results are not directly comparable with those shown on the third day of the second period.

Since there was no apparent drop in the conception rate from the first to the third day in the second period (Table II) in the control diluent and a drop of approximately 10 per cent. in the streptomycin diluent, a further analysis of these results was made (Table V). In this the bulls were divided into two groups, *viz.*, Group "A" bulls with a conception rate in the control diluent of 60 per cent. or over and Group " B " bulls with a conception rate of less than 60 per cent. Group "A" therefore included all the bulls unaffected by streptomycin. All the bulls which had shown a marked increase with streptomycin were included in Group " B." Bulls S3 and G3 were omitted from this analysis in view of the small number of inseminations done with their semen. This analysis showed that in the case of Group "A," *i.e.*, the good bulls, there was a drop in conception rate (significant at the 1 per cent. level) from first to third day with the control diluent and a highly significant drop over the same period with the streptomycin diluent. However, with the bulls in Group " B," *i.e.*, the poor bulls, there was no drop from first to third day with the control diluent, but in the presence of streptomycin the behaviour of this group was similar to that of the good bulls in that a highly significant drop in conception rate from first to third day occurred. These results indicated that streptomycin had no harmful effect on the semen of bulls. It was surprising to find that the semen from the poor bulls did not show the usual drop in conception rate after storage for three days in the control diluent. This was entirely unexpected and no explanation will be attempted at present.

As shown in Tables III and IV there was a highly significant increase in the conception rate of bulls S2, S12, G1, G8, F1 and F4, whereas bulls S1, S3, G3, G9, G10 and F5, which had a high conception rate in the control group, showed no significant increase as a result of the treatment of their semen. The streptomycin effect was found in the semen of all the three breeds of bulls at the Centre, namely, Shorthorn, Guernsey and Friesian.

The highly significant difference in conception rate occurred in the older bulls whose ages averaged 7·4 years whereas the bulls that showed no significant difference in conception rate had an average age of 3·6 years.

DISCUSSION

These results confirm the findings of Almquist and Prince (1950), Easterbrooks, Heller, Plastridge, Jungherr and Elliot (1949) and Foote and Bratton (1950), who showed that the addition to diluents of streptomycin at levels of 500 to 1,000 microgrammes per ml. increased significantly the fertility of bull semen used for artificial insemination.

So far as the authors are aware this is the first time there has been recorded in this country a change in the constituents of a diluent which has resulted in a significant increase in the fertilising capacity of semen used in routine insemination.

Almquist (1949), Almquist and Prince (1950) and Foote and Bratton (1950) also showed that the improved conception rate was due to the effect on the semen from certain bulls and similar results were obtained in this investigation. The failure of Mixner (1949a) and (1949b) to obtain an increase in conception rate by adding penicillin and/or streptomycin to the diluent can probably be explained by this bull factor.

The increase in the fertility of the semen was significant on all three days of use, but lessened in degree as the semen aged. This does not appear to have been noted by other workers and may be of considerable importance in understanding the action of the streptomycin.

The effect of streptomycin on the fertility of semen might be due to one or other of the following reasons: (i) its destruction or control of contaminating bacteria, (ii) its destruction of an organism in semen capable of affecting the fertility of the female or (iii) some possible influence on the metabolism of spermatozoa.

The results of studies made by various workers on the bacteriology of bovine semen have been contradictory and no definite relationship has been shown between bacterial contaminants and fertility. Bush, Ludwick, Ferguson and Fordyce (1950) found a significant relationship between the numbers of bacteria in diluted semen and its fertility when all types of bacteria were considered. Almquist, Prince and Reid (1949), on the other hand, found no relationship between bacterial numbers in semen and its fertility and Prince, Almquist and Reid (1949) found that all types of bacteria identified in semen were present in both fertile and infertile bulls, although there was a tendency for certain organisms to be present in greater numbers in semen from infertile bulls.

From these observations it does not appear likely that fertility is affected greatly by the presence of the usual bacterial contaminants, and therefore it seems improbable that the beneficial effects of streptomycin are derived from the destruction or control of these contaminants. If the reduced fertility in the control group were due to contaminating bacteria the difference between the two groups would probably have increased as the semen aged and the bacteria multiplied.

The possibility of a specific organism directly affecting the fertility of the cow is the postulation that fits most easily the observations made in this investigation. This would account for the immediate effect of the antibiotic and could also explain the individual bull effect. Support is given to the suggestion of a specific infection by the recent work of Sjollema, Stegenga and Terpstra (1949) and Stegenga (1950), who state that there is a venereal type of infertility in cattle in the Netherlands, closely associated with *Vibrio foetus* infection.

The bull G1, which had a long history of good fertility in artificial insemination, is particularly interesting in this connection. This bull had a conception rate of 64·2 per cent.

on 2,753 first services in the year ended September 30th, 1948, and 63·5 per cent. on 3,369 first services in the year ended September 30th, 1949. In the latter part of November, 1949, the conception rate dropped and on 507 first services during December, 1950, and January, 1951, it was 31·6 per cent. The addition of streptomycin to this bull's semen as shown in Table III restored the fertility to normal whereas with the control untreated semen the conception rate remained at the lower level. Since there was no observed change in the normal physical characters of the semen during this period, the introduction of an infection could be a feasible explanation. The history of bull G1 might also explain why the bulls S2, F1 and F4 showed no significant difference in conception rate during the first period and a highly significant difference during the second period.

A factor associated with age may be involved as the semen showing highly significant increases in fertility rate as a result of the treatment tended to be produced by the older bulls. This would not be surprising if the factor were a specific infection since many infections of cattle increase in incidence with age, as a result of the increased frequency of exposure to infection.

The investigations described in this paper are still in progress and will be extended from both the bacteriological and metabolic aspects. If the suggestion of a specific infection proves correct, there is no reason why a similar factor should not affect the fertility of bulls used for natural mating.

SUMMARY

1. The addition of streptomycin calcium chloride complex in the proportion of 1,000 microgrammes per ml. to the normal yolk-citrate semen diluent used in two controlled experiments involving 10,888 cows resulted in a highly significant rise in conception rate based on the percentage of non-returns to the first service after a period of 16 weeks.

2. This increase in conception rate was present on the first, second and third day of use of the semen.

3. The increase in conception rate was highly significant in certain individual bulls with a low fertility rate.

4. Possible explanations of the mode of action of streptomycin on the fertility of semen are discussed and a specific infection is suggested.

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THE VETERINARY RECORD

SEPTEMBER 22, 1951

THE FERTILITY OF CATTLE

INFERTILITY in our herds is not a new problem, but there can be no doubt that as a result of "intensive" domestication such as we have witnessed in recent years, the incidence of this trouble has increased greatly and its effects have a more profound influence on agricultural and national economy.

Veterinary surgeons have been aware of this fact for a long time and they have attempted control by many and various methods. Some men took a special interest in the problem and accumulated a fund of knowledge so that during the recent war when the N.V.M.A. and the Ministry of Agriculture made a combined effort to reduce the incidence of the trouble, their services were utilised in order that up-to-date knowledge and technique might be made available to veterinary surgeons throughout the country. In order to control infertility it is essential to be able to diagnose pregnancy in its various stages and there are few practising veterinary surgeons in this country who cannot form an opinion on the state of pregnancy in a cow or heifer following examinations at suitable times.

Much of the available knowledge on the causes of infertility in cattle centres round genital infections and methods of their diagnosis and control are being practised satisfactorily. Artificial insemination proves of great value in preventing their spread and is a great help in restoring infected herds to satisfactory breeding conditions. When the infections are controlled, there remains a considerable incidence of impaired fertility, and their causes are speculative. The position is not clear, although some aspects are better understood and appreciated; the comparative activity of different hormones may play its part as a cause of irregular breeding.

There is little conclusive information available of the relationship of nutrition to fertility of cows and heifers; in fact, opinions vary so much that it is difficult to make an assessment. Gross deficiencies of essential elements often give rise to recognisable symptoms and lesions before impaired fertility is evident. But infertility due to less gross deficiencies presents an even more difficult problem, and therefore we welcome the observations published in this issue of *The Veterinary Record*. The important deduction from these observations is that a relationship exists between the phosphorus and calcium intake and fertility. The observations were made on 802 animals and over 600 samples of feeding-stuffs have been analysed. An analysis of the figures obtained in the survey is statistically significant, but the authors warn against "exaggeration of the importance of the influence of calcium and phosphorus intakes" and, wisely, regard their findings as sign-posts to further and more extensive investigations.

One of the significant conclusions arrived at by these authors is that "for high fertility in dairy cattle it appeared that the P_2O_5 intake should be considerably higher than the generally accepted 23 grammes for maintenance and 19 grammes for each gallon of milk." The subject they have raised and the results of their observations should receive the attention of some central body; controlled experiments should be instituted, in which interested workers can share.

CLINICAL COMMUNICATION

CAESAREAN SECTION IN A COW WITH TORSION OF THE UTERUS

G. H. ARTHUR, L. VAUGHAN AND J. J. YEATS,

DEPARTMENT OF SURGERY AND OBSTETRICS,
ROYAL VETERINARY COLLEGE

Torsion of the uterus is an occasional cause of maternal dystocia in cattle, and it is usually treated successfully by "rolling" the calving cow. American practitioners favour relief of the condition by the method of suspension of the cow's body into an oblique or vertical position, a block and tackle being attached to an overhead beam and to the hocks of the animal. Some veterinary surgeons (Hynes, 1933) can "swing" the gravid uterus with the cow in the standing position, by introducing the hand into the uterus, or, failing this, the rectum, and by taking a direct or indirect grip on a foetal prominence with a view to causing a sufficient oscillation in the uterus to effect reposition. Auld (1947) recommends a method of abdominal ballottement in which two assistants with clenched fists manipulate the abdomen. One pushes downwards and inwards from the higher right flank, and the other, upwards and inwards from the lower left flank. By pushing alternately, each at the rate of one ballottement per second, the assistants try to generate a swing in the uterus; the veterinary surgeon with his arm in the cow's vagina or rectum grasps a portion of the foetus, and, by pinching it, tries to effect a convulsive movement. With the uterus swinging satisfactorily, the foetus easily is caused to assume the normal position.

Occasionally these well-tried methods fail, and then laparotomy is suggested with a view to applying direct rotational force to the uterus. Thus Franck (1876), cited by Fleming and by De Bruin, untwisted the uterus in 13 out of 15 cases, in which nine animals recovered. According to this writer "retroversion from within the abdominal cavity is a Herculean task, and it is not always possible to twist a weight of 70 to 80 kg. with one hand." Nevertheless, such intra-abdominal methods have been performed successfully in more recent years by operating high in the right flank under local anaesthesia. (Zaruba, 1932; Frost & Danks, 1939; Gold, 1941; Gendreau, 1944; Smythe, 1944, and Welsh, 1944.) For this purpose paravertebral anaesthesia would be satisfactory, but the Animals Anaesthetic Act, 1919, requires that in Great Britain the abdomen of cattle shall be opened only under general anaesthesia, except for rumenotomy. In some cases such intra-abdominal taxis fails, and then the only rational course is to open the uterus and extract the calf. Recently a case was treated at the Surgery Clinic of the Royal Veterinary College, in which the caesarean operation finally was employed.

Subject.—Guernsey cow at the end of her second pregnancy following an insemination on May 16th, 1949.

History.—Signs of abdominal pain, which were present on February 27th, 1950 (287 days' gestation), subsided but recurred on the morning of March 1st, when veterinary aid was sought. The attending veterinary surgeon diagnosed severe uterine torsion, which, in his opinion, was likely to prove irreducible. Arrangements were made to send the cow to the College hospital, where it arrived at 2.15 p.m. the same day.

Symptoms.—The cow was able to walk and stood up during the examination. Rather loose faeces were passed frequently, but there were no expulsive straining efforts or sign of colic.

The pulse rate was 96 to the minute and the body temperature 101·8°. Respirations were at the rate of 46 per minute and were accompanied by a peculiar jerking of the abdomen. On palpating the vagina, it was possible to feel oblique longitudinal folds of its wall, which commenced on the left lateral wall and then ran forwards and upwards to the right to be lost finally in front of the cervix. The latter was palpable and allowed the introduction of two fingers to a distance of 2½ inches. Neither foetus nor membranes could be touched.

Rectal palpation disclosed an easily palpable circular constriction of the uterus about 2 inches in front of the pelvic brim. In front of this the uterus was tense, and, although the unyielding mass of the foetus could be felt within it, it was impossible to identify any part of the calf or to stimulate in it any reflex movements.

By ballottement from the external upper right flank a large bulk of the foetus could be recognised.

The diagnosis was one of left-to-right uterine torsion, and it was decided to try to relieve the condition by casting the cow and rolling it in that same direction, namely, clockwise. Accordingly the animal was put down at the top of a grassy slope and rolled several times in the conventional manner, from dorsal to left lateral recumbency. Vaginal examination showed that this was ineffective, so the animal was rolled in the opposite direction. When these efforts also failed, the decision was made to open the abdomen and attempt reposition of the gravid uterus, and if this also was unsuccessful, to deliver by caesarean section, and then to deal with the twisted uterus.

The cow was prepared for operation by clipping and scrubbing the lower left flank, and cast on her right side.

The anaesthetic was chloral hydrate in 10 per cent. solution, together with 1 per cent. each of sodium citrate and sodium chloride. This was administered by slow intravenous injection until there was complete relaxation of the tail and commencing nystagmus. At this stage of light anaesthesia the patient had received about ¾ oz. of chloral. Although this amount gave anaesthesia for the skin incision, infiltration with local anaesthetic was necessary in order to proceed painlessly through the transversalis muscle and peritoneum. The direction of the abdominal incision was from 2 inches above the fold of the left flank downwards, and forwards towards the milk-well for a distance of 12 inches. This was later enlarged to 14 inches.

On incising the peritoneum a pint or two of serum escaped, and the depth of the wound was seen to be occupied by omentum with small intestine intruding from above. The latter had to be retracted manually, but attempts to reflect the omentum upwards and forwards failed. Thus it was impossible to see the uterus, but on deep palpation an extremity of the gravid cornu, containing foetal limbs, was located projecting beyond the posterior commissure of the wound. The clockwise torsion of the uterus in front of the pelvic brim was clearly palpable, but vigorous efforts to rotate the uterus around its longitudinal axis in an anticlockwise direction were fruitless. The uterus was under such tension that it was considered inadvisable to prolong these efforts, and as no reflexes could be excited in the foetus it was thought best at this stage to open the uterus and extract the foetus. This was a difficult operation, however, because there was only a small part of the uterus available for incision. The cow was thereupon rolled on to her back and this manoeuvre, together with strong lifting of the uterus, brought a sufficiency of it to view. An incision 5 inches long was made into the uterus, the allanto-chorion which bulged through was opened and its fluid allowed to escape. The amnion was incised and the hind feet of the calf which emerged were pulled out of the abdomen. Then by careful alternate traction on these limbs the foetal buttocks were negotiated

through the wound, but on further traction, an oblique tear, approximately 6 inches long, occurred forwards from the uterine incision. The considerable tautness of the organ contributed to this tearing. Extraction of the calf was completed, and it was now showing reflex movements. It was a full-term female calf and began to breathe at once.

After exploring the uterus for another calf and deciding because of their firm attachments to leave the foetal membranes *in situ*, the problem now was how to suture the extensive rent in the uterus, for this disappeared forwards into the abdomen. It was sutured as far as possible, and at this point it was a simple matter to correct the torsion of the organ by simply turning it in an anti-clockwise direction through an angle of approximately 180°. This made the uterine opening more available, so that its repair could be completed. At this stage, a manual examination of the vagina confirmed that the torsion of the uterus had now been corrected.

One million units of penicillin were instilled into the abdominal cavity before repairing the flank wound. The peritoneum and transversalis muscle were closed together by a single continuous catgut suture and the remainder of the abdominal wall—oblique muscles, subcutis and skin—by one layer of eversion sutures of ½-inch tape.

Two and a half hours after beginning the operation the cow got up and drank a gallon of glucose water. The calf then stood up and suckled. The maternal pulse rate was now 106 per minute and the body temperature 101·2°. The respirations were fast and laboured. One million units of penicillin were given by intramuscular injection and the patient rugged-up.

Twelve hours later the bulk of the foetal membranes were hanging from the vulva, and gentle traction caused complete expulsion.

Two million units of penicillin were given on each of the three days following the operation. An electrically-heated blanket was also applied. Cow and calf made steady progress and were discharged from hospital seven days after admission.

The cow made a good recovery and milked well, and its calf was reared. The dam was inseminated on August 20th, 1950, and again on September 10th, and a normal gestation ensued. It calved without aid on June 24th, 1951, and the foetal membranes were passed within an hour of the birth of the calf.

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SANITARY INSPECTORS' TRAINING

The need for the provision of university facilities to enable a sanitary inspector to take a degree in sanitary science was emphasised by Mr. J. C. Dawes, of London, in his presidential address to the annual conference of the Sanitary Inspectors' Association at Margate. It was remarkable, he said, that such facilities did not exist in this country after more than 100 years of organised local sanitary administration.

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WEEKLY WISDOM

It would be nice to know that the pollution of the air we breathe was regarded by our health authorities with the same concern that is shown by societies for the preservation of ancient buildings.—Professor D. W. SMITHERS.

ABSTRACT

Treatment of Fluoroacetate Poisoning in Mice and Dogs*

Sodium mono-fluoroacetate, known as 1080, is used as a rodenticide. Its high toxicity makes it a danger to all species of animals and to man. The administration of a combination of ethyl alcohol and sodium acetate had previously been reported to be of some use as an antidote to 1080 poisoning in mice. The authors carried out further trials and showed the treatment to be satisfactory.

On applying the same treatment on dogs it was found to have some antidotal effect but only when administered immediately after the 1080 was given.

Because toxic doses of 1080 cause severe convulsions in dogs barbiturates were administered to control these and it was then found that the alcohol-acetate combination added nothing to the benefit derived from the barbiturates.

Phenobarbitone (presumably sodium phenobarbitone) was given subcutaneously in doses of 25 to 50 mg. per kg. in anticipation of the convulsions and then, if in spite of this the dog showed excitement or twitchings, nembutal in doses of 5 to 15 mg. per kg. was given intraperitoneally and repeated as often as necessary. Figures given show that up to 100 per cent. success can be obtained provided treatment is commenced between one-half to three hours after poisoning and provided the lethal dose is not too high.

The dose of 1080 which would kill 50 per cent. of dogs was found to be 0·066 mg. per kg.

D. W. J.

* **Treatment of Fluoroacetate Poisoning in Mice and Dogs.** TOURELLOTTEE, W. W., & COON, J. M. (1951.) *J. Pharmacol.* **101.** 82–91.

NOTES AND NEWS

Diary of Events

Sept. 22nd.—300th Meeting of the Biochemical Society, at the Rowett Research Institute, Bucksburn, Aberdeenshire, 11 a.m.
Sept. 24th.—Annual General Meeting of the Association of Veterinary Teachers and Research Workers at Eastbourne (Grand Hotel), 11.30 a.m.
Sept. 27th.—Annual General Meeting and Dinner of the Royal (Dick) Veterinary College Alumnus Association at Eastbourne. (See Notice.)
Sept. 23rd–29th.—Sixty-ninth Annual General Meeting and Congress of the National Veterinary Medical Association, at Eastbourne.
Oct. 4th.—Meeting of the Central Division, N.V.M.A., at the Royal Veterinary College, Camden Town, N.W.1, 6 p.m.
Oct. 9th.—Meeting of the South-Eastern Division, N.V.M.A., at Maidstone (Royal Star Hotel), 2.30 p.m.

* * * * *

Agreement between the R.S.P.C.A. and the N.V.M.A. in regard to the Joint Veterinary Advice and Free Treatment Schemes

This Agreement, which came into operation in 1939 and was revised in 1950, has again been reviewed by both organisations and will continue to operate with certain modifications which take effect from October 1st, 1951.

The agreed modifications provide for the adoption of a new procedure in dealing with proposals for the establishment of new clinics, etc., received from their local branches and referred to the Association by Headquarters R.S.P.C.A.; also for an increase in the fee payable for normal cases dealt with under the voucher scheme and for

animals painlessly destroyed. In addition, the mileage allowed for cases visited has been improved.

A copy of the new Agreement can be obtained from the General Secretary, N.V.M.A., 36, Gordon Square, W.C.1, upon request.

* * * * *

Arrangements at Slaughterhouses for Dealing with Casualty Animals

The Association is interested in collecting information on various ways in which meat—which might otherwise be suitable for human consumption—is being lost to the country.

It is known that livestock owners, on occasion, send "casualty" animals to the knacker for slaughter because of difficulties experienced in arranging for slaughter through the Ministry of Food or by a private slaughterman. Furthermore, such an owner may receive a better price from the knacker than from the Ministry of Food, which pays only for that part of a carcase suitable for human consumption.

The Association would therefore welcome any evidence bearing on this matter, particularly in rural areas, and members are asked to send any particulars they may have as soon as possible to the General Secretary, N.V.M.A., 36, Gordon Square, London, W.C.1.

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Dishorning of Cattle

As announced in recent issues, Council, N.V.M.A., has adopted the following resolution sent forward by the Technical Development Committee:—

> "That this Committee, having collected a considerable volume of evidence on various methods of dishorning cattle, expresses disapproval of the method of dishorning involving the use of a ligature whether or not an anaesthetic is given at the time of application, on both humane grounds and lack of efficiency."

In further discussions reported to Council the Technical Development Committee recommended that dishorning must be carried out under an efficient anaesthetic, the choice of which must remain within the discretion of the veterinary surgeon concerned.

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PERSONAL

Births.—LAMBERT.—On August 17th, 1951, at Hatch Street Nursing Home, Dublin, to Jean, wife of N. H. Lambert, M.R.C.V.S., a sister for Bruce—Jeanette.

ROSS.—On September 12th, 1951, at Reading, to Ray, wife of Lieut.-Colonel J. McL. Ross, M.R.C.V.S., a daughter.

. . . . . .

Marriage.—GLEDHILL—PETERS.—On September 14th, 1951, at St. George's Church, Modbury, S. Devon, Kenneth Charles Gledhill, M.R.C.V.S., son of Mr. and Mrs. J. Gledhill, Halifax, Yorkshire, to Mary Peters, daughter of Mrs. C. R. Bailey, of Parliament Hill, London.

. . . . . .

Forthcoming Marriage.—TEAKLE—BURNS.—The engagement is announced between John Anthony Teakle, M.R.C.V.S., son of Mr. and Mrs. H. O. Teakle, Somerton, Somerset, and Mary Marcia Burns, second daughter of Mr. and Mrs. Burns, Ashfield, Ross-on-Wye, Herefordshire.

R.C.V.S. OBITUARY

SMITH, John Coningsby, Five Oaks, Stokesley, Middlesbrough, Yorks. Graduated N. Edinburgh, December 19th, 1903. Died September 10th, 1951; aged 70 years.

O'NEILL, Joseph Benedict, Belmore House, Killean, Newry, Co. Down. Graduated Dublin, July 8th, 1947. Died September 4th, 1951; aged 33 years.

We deeply regret that Mr. O'Neill lost his life as the result of a tragic accident. Mr. O'Neill was motoring with Mr. Maxwell Chunningham, of the Bridge Café, Newry, when a wrong turn was taken at the village of Annagassan, about ten miles south of Dundalk, and the car plunged into the tidal River Glyde. After the tide receded both men were found dead in the car.

CLIFFORD, W. A., 345, London Road, St. Leonards-on-Sea, Sussex. Graduated London, July 5th, 1887. Died September 9th, 1951.

SIDDALL, Ernest Lloyd, Captain N.Z.V.C., 217, Springfield Road, St. Albans, Christchurch, New Zealand. Graduated London, July 14th, 1900. Died August 4th, 1951.

Mr. Ernest Lloyd Siddall, who passed away at Burwood Hospital, Christchurch, was living in retirement after having served for a number of years with the Department of Agriculture in the Dominion.

William Kearney

AN APPRECIATION

I write to do honour to the memory of my old friend William Kearney, whose death has been reported recently.

William Kearney and I travelled out to Kenya together in June, 1913, on our first tour of service. He went to the laboratory at Kabete to assist that eminent veterinary pathologist R. E. Montgomery, on whom he fashioned many of his methods and not a few of his mannerisms. Kearney and I saw much of one another during those early months before the 1914 war, and I well remember the early morning on F. O. B. Wilson's farm at Ulu when we each shot our first lion. It mattered not to us that the lions turned out to be lionesses with no manes; the skins were duly mounted and sent home. The story of that great occasion in our young lives was frequently told, and who can blame us if in the telling some of the details may have got mislaid.

Later in our lives, in 1924, Kearney and I again found ourselves arriving in Nigeria almost simultaneously—he to establish the new laboratory at Vom, the buildings of which were then nearing completion.

Kearney's great energy, organising ability and the knowledge of the production of antirinderpest serum which he had gained in Kenya, stood him in good stead in Nigeria and it was not many months before he had overcome all initial difficulties and most of the snags proverbially associated with all pioneer work in Africa, and made available ample quantities of serum for use in the field.

One serious difficulty which had to be overcome at that time was the high incidence of dormant trypanosomiasis infection among the young cattle to be used as rinderpest virus producers. Kearney, by careful experiment, confirmed the earlier work of Richardson in Uganda, that a solution of potassium antimony tartrate added to rinderpest blood in a final dilution of 1:10,000 killed the trypanosomes but did not affect the rinderpest virus. This pioneer discovery was of great importance to us in the field, who were ready to inaugurate the scheme of large-scale immunisation against rinderpest, a disease which at that time in Nigeria was sweeping over the country in periodic waves and decimating the herds in its passage. The organisation which Kearney planned for the production of antirinderpest serum in Nigeria stood almost unaltered right up to 1943, when goat attenuated rinderpest vaccine replaced the serum-virus simultaneous method of immunisation. Kearney was a painstaking and brilliant research worker who took nothing for granted, and it was a grave loss to the Veterinary Department of Nigeria when, in 1927, because of ill-health, he decided to quit the Colonial Service.

Bill Kearney was a cheerful and friendly man and a most charming host. Many were the good nights which the three or four pioneer members of the veterinary staff at Vom spent on the veranda of his house—the only house of permanent construction in the station at that time—and there passed the enchanting period between sundown and dinner-time. Those were happy nights and the memory of them and of the man will ever remain to the writer ineradicable epochs in those years spent in Africa with William Kearney as close friend and associate and professional colleague.

To his widow and family I extend my deepest sympathy in their profound grief and irreparable loss.

W. W. H.

ADDRESSES OF DISEASE-INFECTED PREMISES

The list given below indicates, first, the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

SWINE FEVER:

Angus.—Tealing Airfield, by Dundee (Sept. 10th).

Bucks.—Smallholding, Green Street, Haylemere, High Wycombe (Sept. 10th).

Cambs.—New Farm, Whaddon, Cambridge (Sept. 8th).

Cheshire.—Moss Farm, Marton, Chelford (Sept. 10th); Sandhole Farm, Hulne, Wallfield, Congleton (Sept. 11th).

Herts.—Wid End Farm, Southend, Perry Green, Much Hadham (Sept. 10th).

Hunts.—Wood Lane Farm, Ramsey (Sept. 12th); Gordon Arms, Orton Longueville (Sept. 12th).

Isle of Ely.—Stocking Drove, Chatteris; Beezlelings Farm, 40, Bank Doddington (Sept. 10th); 31, Gracious Street, Whittlesey; Warboys Road, Acre Fen, Chatteris (Sept. 12th); Willey Fen, Doddington Road, Chatteris; Hulswood Farm, Somersham Road, Chatteris (Sept. 14th); 126, St. John's Road, Ely (Sept. 15th).

Kent.—Castle Acre, East Farleigh (Sept. 10th).

Lincs (Holland).—G. E. Baley, Yard in North Street, Crowland (Sept. 11th); White Cross Farm, Tydd St. Mary (Sept. 12th).

Notts.—Chapel Gardens, Victoria Road, Netherfield (Sept. 10th).

Oxford.—Court Place Farm, Old Marston (Sept. 10th); Heath Farm, Great Rollright (Sept. 11th).

Staffs.—Park Lane, Cheadle (Sept. 11th); Peartree Cottage, Brockten, Eccleshall (Sept. 14th).

Warwick.—Cutcheon Field Farm, Studley (Sept. 10th); 9, Elendon Road, Marston Green; 36, Buchy Close, Dickens Heath, Shirley (Sept. 12th).

Yorks (E.R.).—Dairycoates Siding Allotments, Hull (Sept. 11th).

Yorks (W.R.).—Southfield Farm, Darley, Harrogate (Sept. 10th); Pit Sidings Allotments, Insterville, Asken, Doncaster; 11, Brown Lane, Leeds, 11 (Sept. 11th).

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A.I. "STRATEGIC RESERVE" CENTRE IN ANGLESEY

In its report of the opening ceremony, the *Farmers' Weekly*, in its issue of September 14th, states that an artificial insemination centre which may serve as a "strategic reserve" for the whole country if other centres become temporarily paralysed by foot-and-mouth disease has been opened by the Milk Marketing Board at Llangefni, Anglesey. Foot-and-mouth disease has never been reported in the island county. More than 1,500 farmers from Anglesey and Caernarvonshire attended. The centre has 29 bulls—five Ayrshires, seven Friesians, six Shorthorns, six Welsh Blacks and five Herefords—and service for other breeds can be obtained. Situated near the Board's Llangefni depot, the centre, which is under the direction of Mr. D. Lornie, M.R.C.V.S., has 14 acres of land, with an administration block, a laboratory and a bull barn for 30.

Speaking at the opening, Mr. Ben Hinds, Chairman of the M.M.B., asked for full support for the venture, for three reasons—it had cost the Board a lot of money to start; nothing was more important than this development in breeding, and great benefits would be bestowed on all farmers who regularly made use of the service.

Mr. Hugh Owen, Clynnog, Caernarvon, Chairman of the Board's Advisory Committee, declared: "By the wise use of this centre the effect on the produce of stock, both in milk and beef, will be tremendous."

Dr. Joseph Edwards, scientific adviser to the M.M.B., speaking of the improvements to herds already brought about by A.I., described a cow conceived by the method which was placed third at a recent Devon sale, but fetched £17 more than the champion when it was auctioned the same day.

Following the opening, 13 of the bulls were paraded, and their points were outlined by Mr. W. E. Bowden, head of the Board's Dairy Husbandry Department.

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PRODUCTION OF ACTH IN BRITAIN

In its issue of September 14th, *The Times* recorded that about 120 specialists and doctors, including representatives from America and the continent, were meeting privately at Harrogate to discuss their experiences in the use of the drug ACTH, which they have been using in clinical researches, notably those related to rheumatoid arthritis. It is intended to publish the proceedings in the medical Press, and also in book form, for the information of general practitioners and in the expectation that the Ministry of Health will give its acceptance to ACTH.

"Apart from a small quantity obtained from Scotland, the Ministry imports the drug from laboratories in America. In anticipation of official acceptance of the drug and its release to practitioners generally, it is intended to set up laboratories next year on a site already purchased at Eastbourne."

* * * * *

A new record for British laying tests has been set up by a Rhode Island Red, entered by Mr Joseph Brown, Menston-in-Wharfedale, in the Yorkshire Laying Test. She has laid 325 eggs in 336 days. The previous record was 318 set up in 1931-32 and equalled in 1934-35.

* * * * *

A number of livestock owners have been using for stock feeding purposes quantities of "fish meal" and "meat and bone meal" manufactured for use solely as fertilisers, say the N. Ireland Ministry of Agriculture. The Ministry warns that this practice is dangerous.

Mr. H. Wilson, blacksmith at Settle, Yorkshire, has forwarded a pair of cowshoes to York museum. Mr. Wilson's father used to make shoes for cows when they had to be driven long distances to market.

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It is announced by the University of London that, owing to the illness of the lecturer, the special university lectures in veterinary science which were to have been given by Professor C. Romijn at the Royal Veterinary College on October 16th, 17th and 18th have been cancelled.

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the N.V.M.A.

THE ECONOMICS OF VETERINARY PRACTICE

Sir,—Having read the recent correspondence on the Economics of Veterinary Practice, it is refreshing to read Mr. A. Steele-Bodger's third case history on streptomycin.

I am now expecting to see the inauguration of a correspondence on the Economics of Stock-farming in *The Farmer's Weekly*.—Yours faithfully, P. T. HEATH, 34, Abbotsbury Road, Weymouth. *September 7th*, 1951.

DISEASES OF ANIMALS ACT, 1950—GREAT BRITAIN

Summary of Returns of Confirmed Outbreaks of Scheduled (Notifiable) Diseases

Period	Anthrax	Foot-and-mouth	Fowl Pest	Parasitic Mange*	Sheep Scab	Swine Fever
Aug. 16th to 31st, 1951	10	2	9	—	—	119
Corresponding period in—						
1950	8	3	1	—	—	42
1949	8	2	5	—	—	—
1948	5	—	10	—	2	1
Jan. 1st to Aug. 31st, 1951	299	28	595	—	4	755
Corresponding period in—						
1950	258	19	102	—	19	93
1949	130	13	357	—	29	5
1948	67	—	240	1	33	23

* Excluding outbreaks in Army Horses.

Tuberculosis (Attested Herds) Schemes

The number of Attested Herds, *i.e.*, herds officially certified as free from Tuberculosis as at August 31st, 1951, was as follows:—

England	Wales	Scotland	Total (Great Britain)
32,655	18,832	15,416	66,903